Studying cluster resolution in the sPHENIX tracking detectors

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Macro

I made a macro to extract from Mike's tracking evaluator the cluster statistics for clusters associated with reconstructed tracks.

It is intended to be run on 2-track events (pions or electrons are fine), I usually use 2,000 to 5,000 events.

The macro is in the:
analysis/Tracking/
    cluster_resolution.C
    ntuple_variables.C

(or will be when I figure out how)

Extracted quantities

Layers / track:

Loop over all clusters for a track, and count number with:
- layer < 3   // MAPS
- layer > 2 and layer < 7   // INTT
- layer > 6   // TPC

Note: can have > 1 hit sensor in any layer with ladders.

Hits / cluster

Loop over all clusters for a track and histogram "size".

(Reconstructed cluster location) - (true location):

Loop over all clusters for a track and record:

$\sqrt{[(x\text{-}gx)^2 + (y\text{-}gy)^2]}$

and give it a sign based on the direction of $\Delta\Phi$

Cylinder cell model results

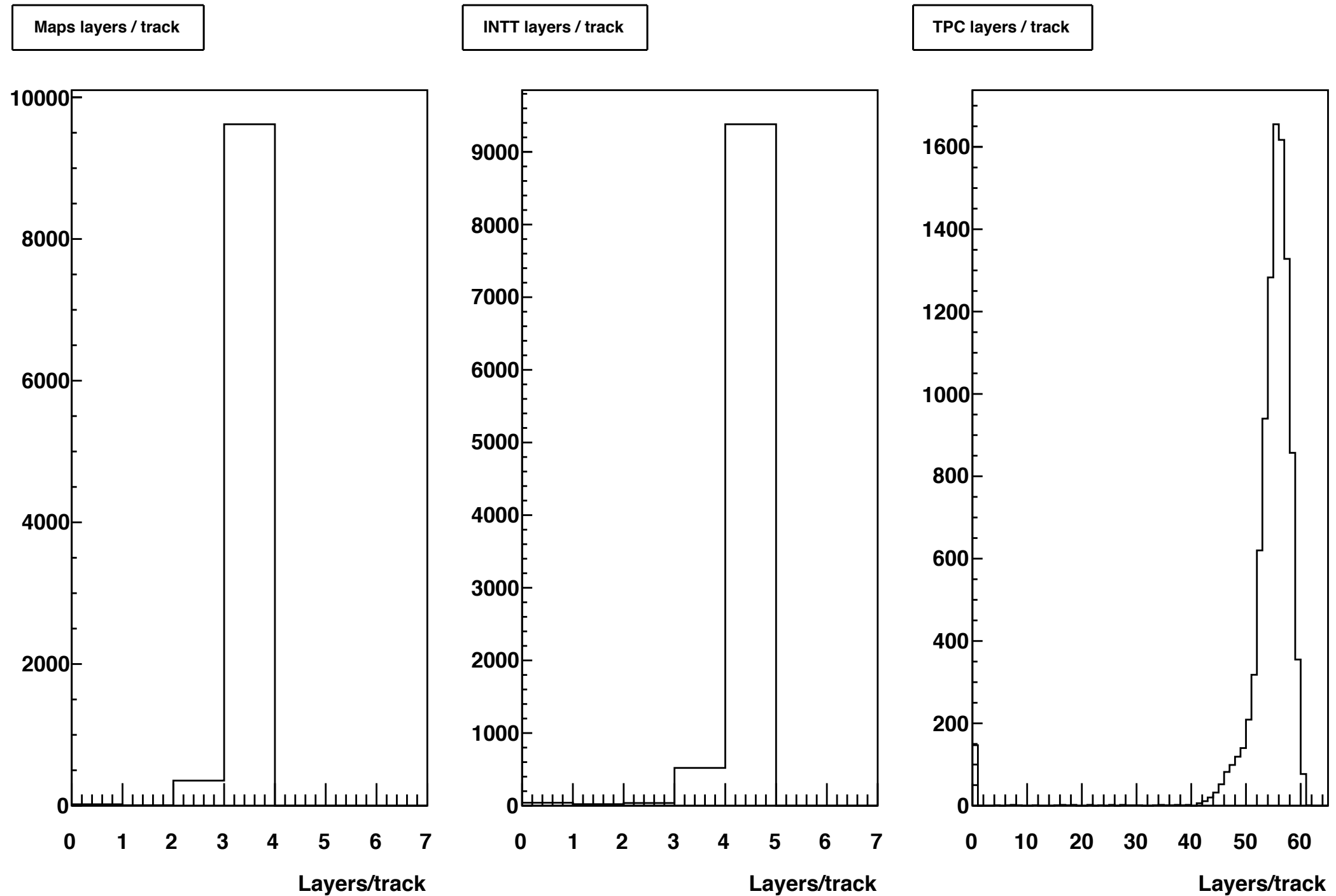## 3 MAPS cylinder layers
4 INTT cylinder layers
60 TPC layers

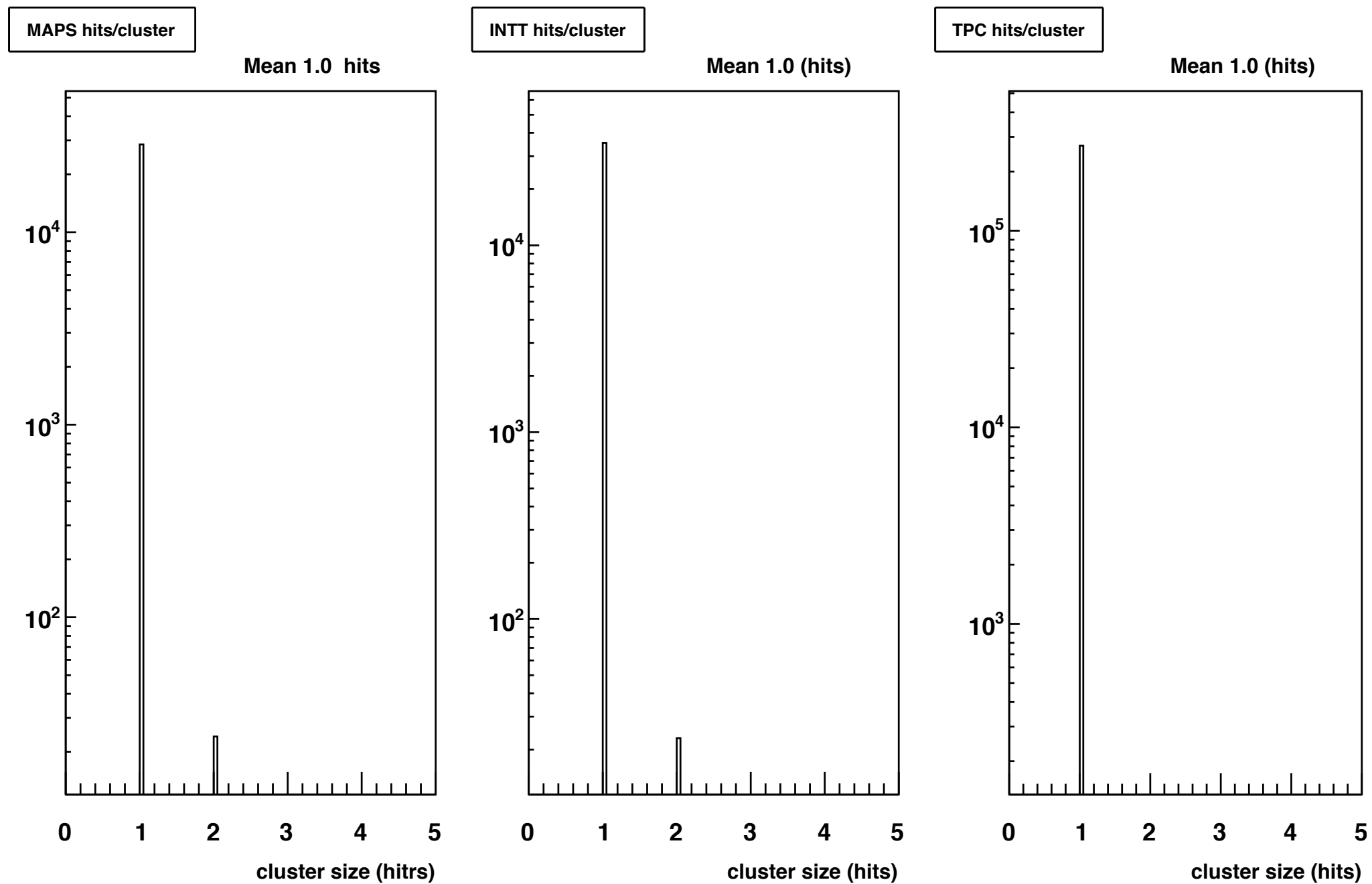## G4_Svtx_maps+intt+tpc.C

from 5K events with 2-pions each
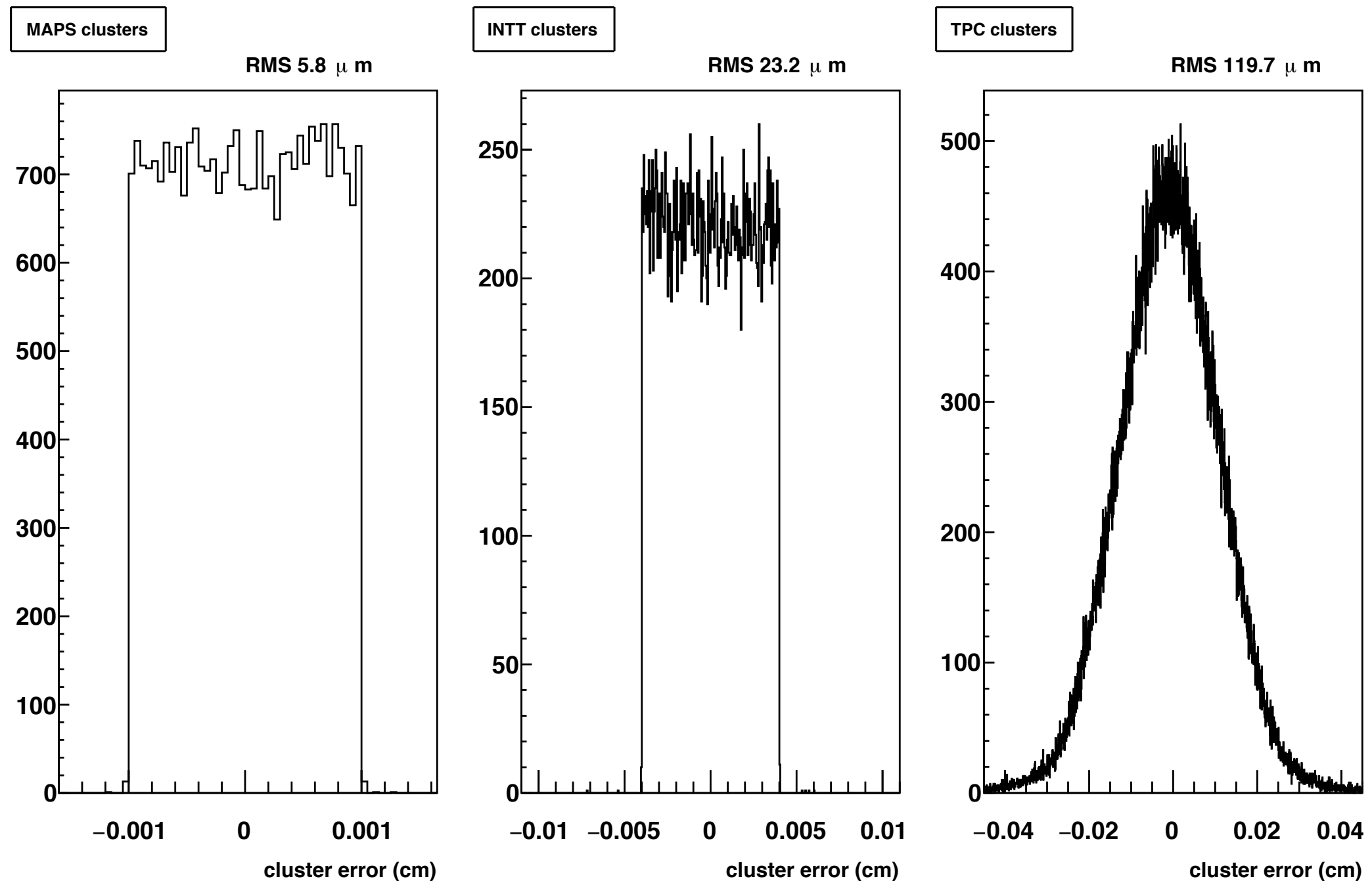## p_T = 1 and 2 GeV/c

Layers per track

Make sense: most tracks hit 3 MAPS layers, 4 INTT layers and > 50 TPC layers

Hits per cluster

Make sense: straight tracks, so most tracks hit only one cell.

Reconstructed cluster location - true location

MAPS RMS is 20 μm/√12 and INTT RMS is 78 μm/√12 - looks OK!
TPC RMS is 120 μm - seems too small

MAPS ladder and INTT ladder model results
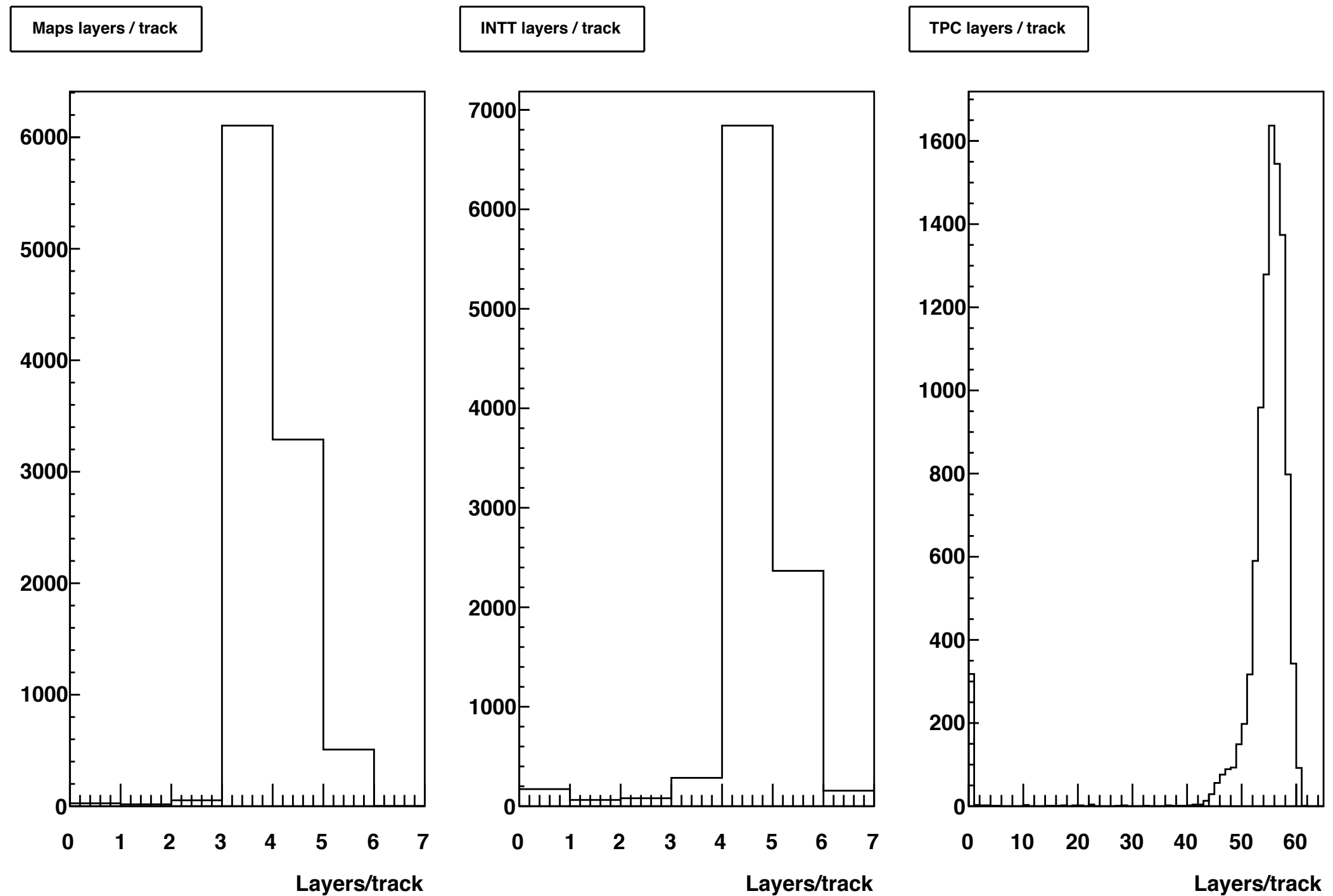
3 MAPS ladder layers
4 INTT ladder layers
60 TPC layers

"G4_Svtx_maps_ladders+intt_ladders+tpc.C
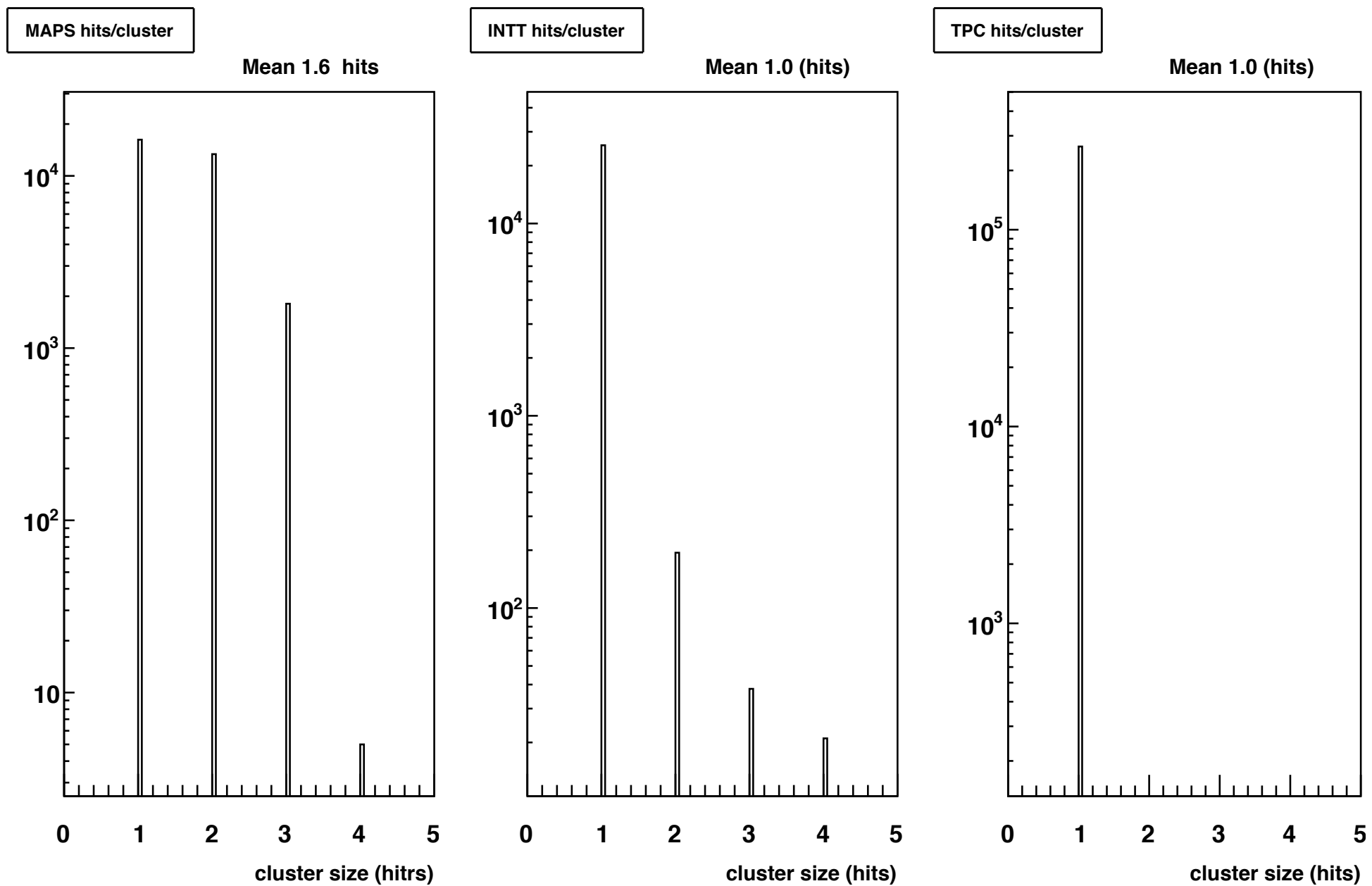
from 5K events with 2-pions each
p_T = 1 and 2 GeV/c

Layers per track

Maps layers / track

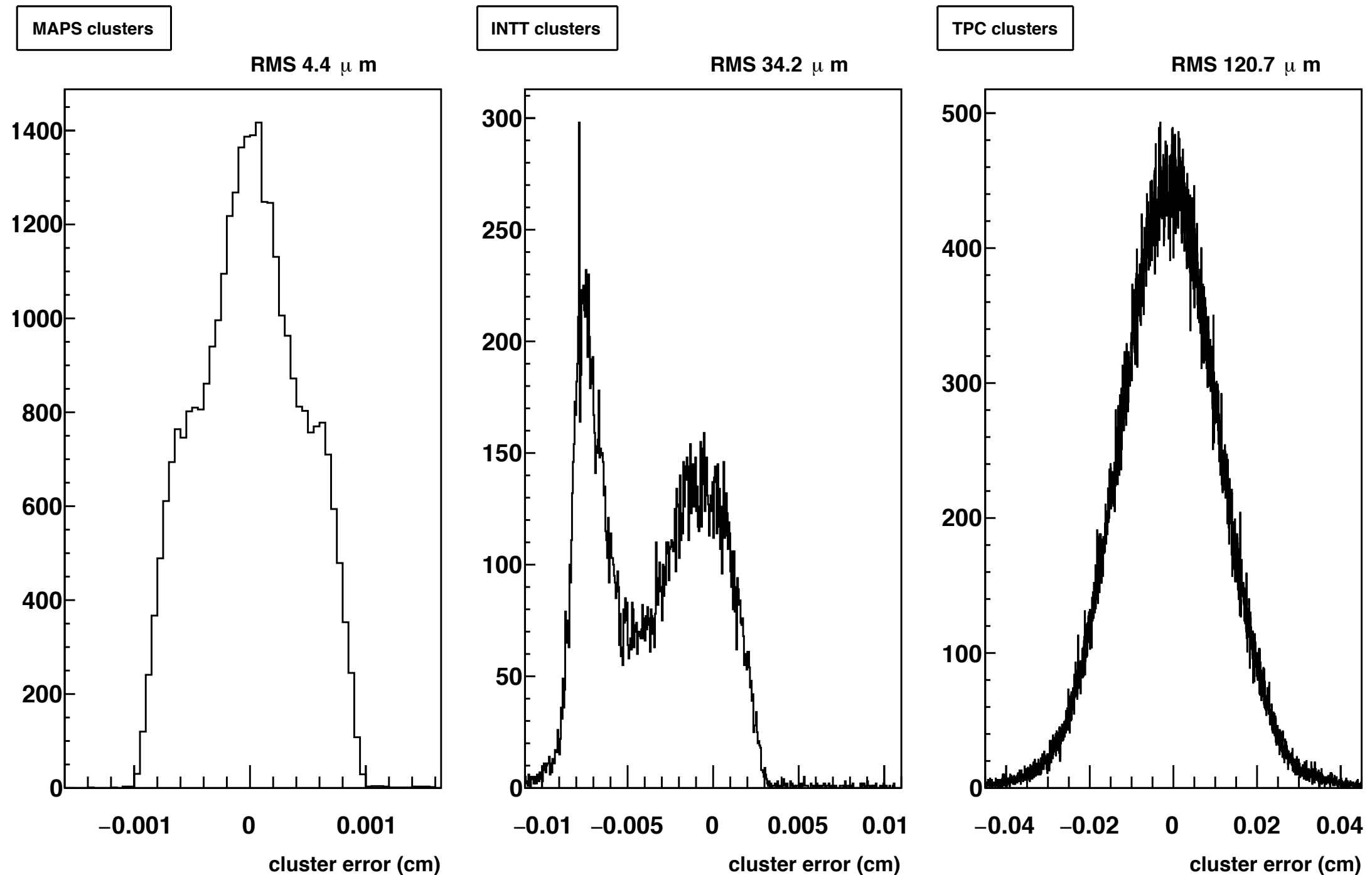INTT layers / track

TPC layers / track

Ladders have overlaps in azimuth, so expect multiple hits/layer - looks OK!
TPC should be same as for cylinder cell case

Hits per cluster

For MAPS ladders, get 1.6 hits/cluster! This may be due to the ladder tilt.
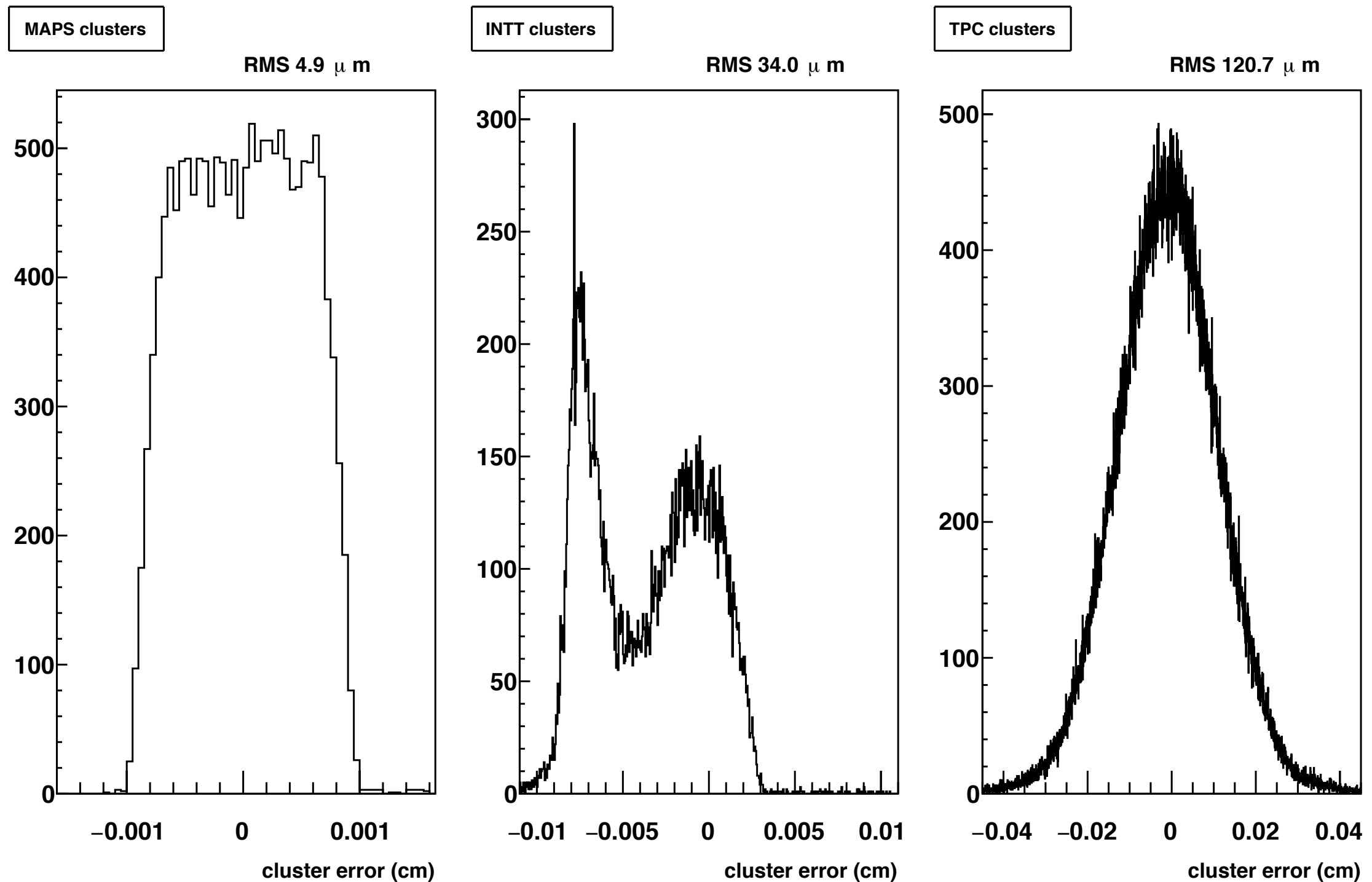
Reconstructed cluster location - true location

Clearly something wrong for INTT ladders. Looks like off by one strip. Gaku is looking into it.
The MAPS distribution is related to the hits/cluster - see next slide ....

Reconstructed cluster location - true location

MAPS clusters — RMS 4.9 μ m

INTT clusters — RMS 34.0 μ m

TPC clusters — RMS 120.7 μ m

cluster error (cm)

The MAPS distribution when I select clusters with only 1 hit - looks reasonable.

Reconstructed cluster location - true location
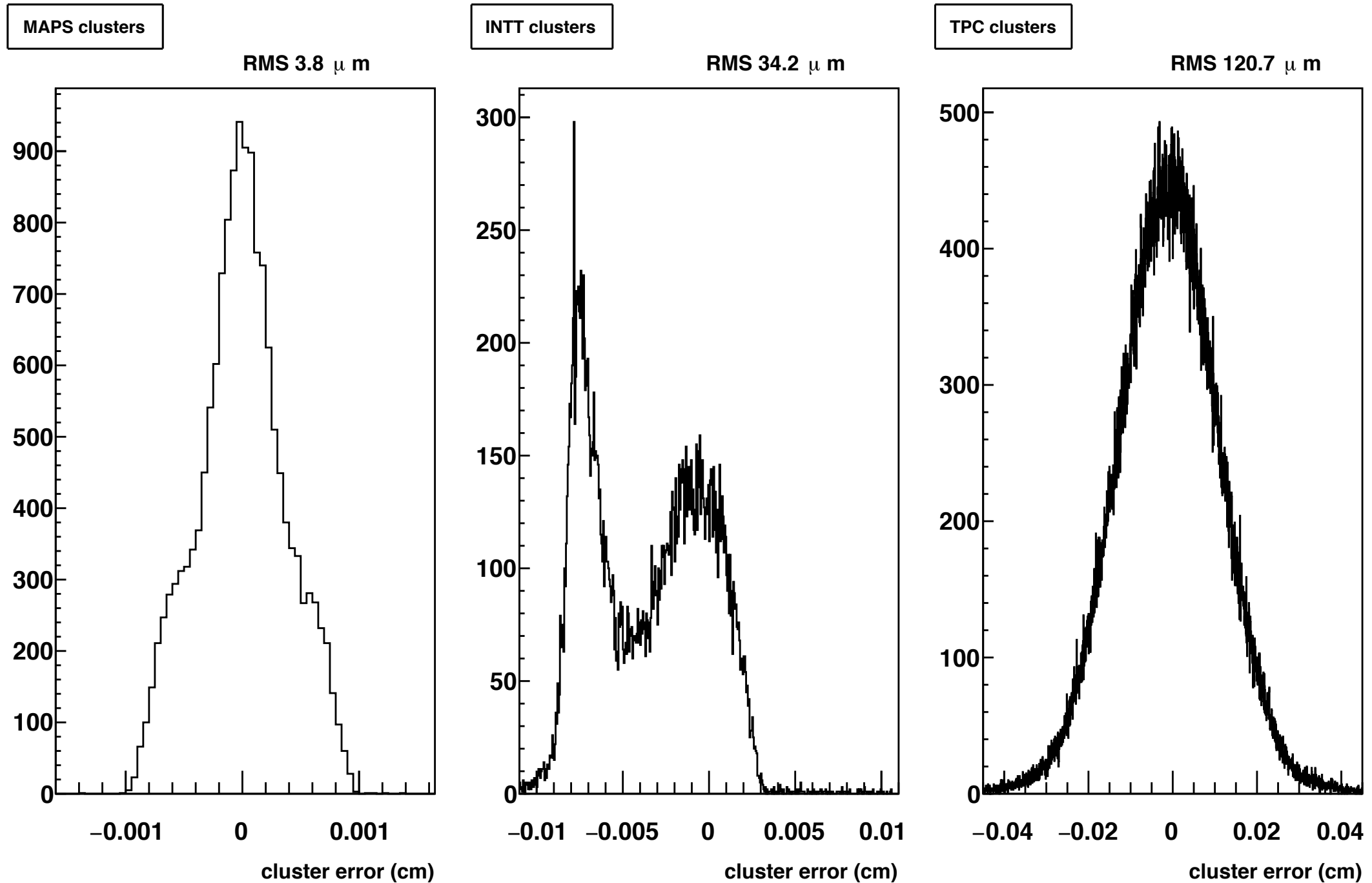
The MAPS distribution here is for > 1 hit per cluster - as expected. the position is better defined if the track cross pixel boundaries - looks OK!

Conclusions

The TPC cluster resolution is about 120 μm - is this expected?

The cylinder MAPS and cylinder INTT cluster distributions look as expected.

For the INTT ladders, the clustering has a problem, Gaku is investigating.

For the MAPS ladders, the clusters look OK, but (I think) because of the ladder tilt there are a significant number of tracks that cross pixel boundaries
- Because we do not do charge sharing, this makes the cluster resolution better for the tracks that cross boundaries - probably not realistic.
- Should we introduce charge sharing for the MAPS pixels?